Space Weather Technical Forecast

Issued on Tuesday, 30 July 2024 at 01:24 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: CME arrivals expected days 1 and 2 (30 Jul-31 Jul). Given the number of CMEs observed over the past 24 hours and the difficulties encountered analysing multiple CMEs there remains a risk of further CME arrivals on days 3 and 4 (1 and 2 Aug). G1-G2 / Minor to Moderate Storms, with a chance G3 Strong Storms. Moderate to High solar activity.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: High with an impulsive X1.5 flare at 29/0237 UTC from AR3766 in the south-centre disc. Several other M flares. There are three magnetically complex regions in close proximity in the south-centre disc, with more than one delta spot evident within this cluster. Other regions of note include AR3770 in the north-centre disc, which after rapidly emerging on 28 Jul, is now maturing but also developing some complexity on its northern most intermediate spots, with another delta configuration evident. While to the southwest disc, AR3762 and AR3768, while showing some decline, also contain small delta-spots, and have a history of producing flares that produce CMEs. There are ten active regions currently on the disc.
A number of CMEs were observed in imagery, with the partial halo CME from off the southwest-disc assessed as being Earth-directed. This has been attributed to a combination of the M2.6 of AR3762 at 1250 UTC and the long period M1.7 flare from AR3768.

Solar Wind / Geomagnetic Activity: Slow wind conditions persisted through the period. Solar winds speeds, as measured by ACE at L1, declined slightly from around 400 km/s to near 320 km/s. Density was below average. Interplanetary magnetic field, Bt, was weak 4-6nT, with north-south component, Bz, variable in the range +6nT to -6nT. Phi angle was predominately positive (away from the Sun). Geomagnetic activity was Quiet to Unsettled (Kp1-3).

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux observed by GOES18 is at background levels. High energy electron flux (greater than 2MeV) observed at GOES16 was at background to moderate levels. The 24-hour fluence was below the Active threshold but on a steep rising trend. 2.62e7 integrated pfu was observed at 30/0000UTC.

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Met Office Space Weather Technical Forecast

Four-Day Space Weather Forecast Summary

Solar Activity: Moderate to High activity is expected with further M-class flares expected and chance of further isolated X-class flares.

Solar Wind /Geomagnetic Activity: A number of CMEs are expected to arrive through the period. The first is expected early day 1 (30 Jul), originating from an M-class flare on 27 Jul, but potentially combining a further weak filament. The CMEs from the M9.9 early on 28 Jul, and then the M2.6 and long period M1.7 later on 28 Jul are then expected to arrive either late day 1 or day 2 (30-31 Jul) perhaps combining into a single arrival, although this is currently low confidence. Further CMEs may arrive later in the period. Overall, initially Quiet conditions are likely to increase to G1-G2 Minor Storm with any CME arrival with a slight chance of G3 Strong storms.

Energetic Particles / Solar Radiation: High energy proton flux is currently at background. Should any notable flares occur there is a likelihood of this increasing above background, with a slight chance of exceeding the S1/Minor Storm threshold. This is due to the increasingly geoeffective location of the sunspot regions on the disc. The high energy electron flux is forecast to be mostly at background levels. The associated 24-hour fluence is expected to remain below the Active threshold (1e8 integrated pfu).

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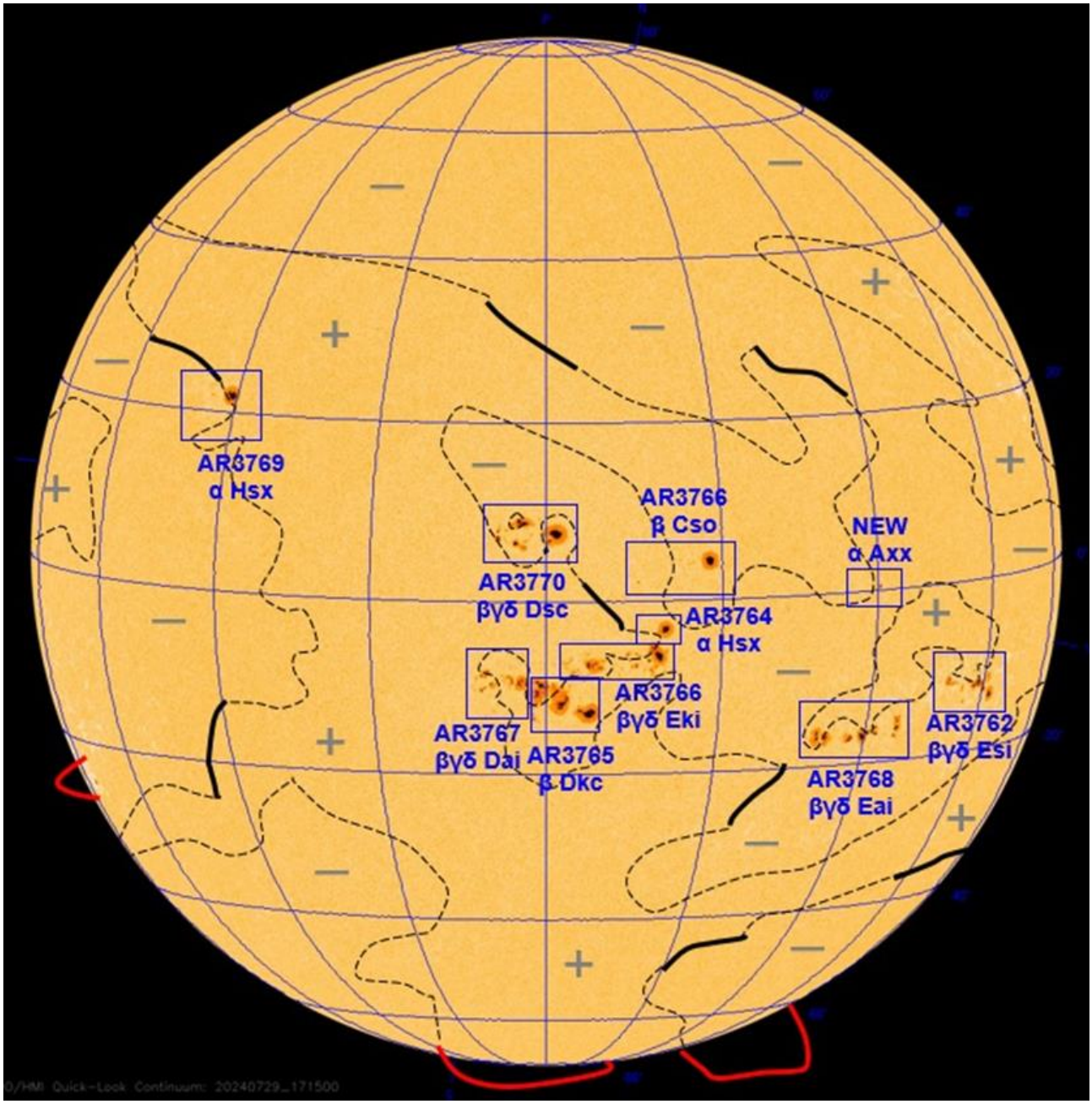
Figure 1. Solar Analysis Valid 29/2000UTC.



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Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

There are number of Earth-directed CMEs that are expected to arrive through this period.
The CME from the M3.1 flare of AR3762 on 27 Jul is anticipated to arrive early day 1 (30 Jul). This is only moderate confidence due to difficult analysis with overlapping CMEs in imagery, including a notable far-side event. However the CME is likely to also cannibalise a weak filament eruption off the southeast disc that occurred on 26 Jul, leading to the potential for a stronger arrival. Elevated solar winds, with G1-G2 Minor to Moderate storms are likely, with a chance of isolated G3 Strong Storms.
There are two further CMEs of note. The first from the M9.9 from AR3766 on 28/0200 UTC, and the second from the combination of the M2.6 at 28/1250UTC from AR3762 and the long duration M1.7 at 28/1422 UTC from AR3768, off the southwest disc. These are then expected to arrive late day 1 or day 2 (30-31 Jul), with a chance of these also combining into a single stronger arrival event, or being in fairly short succession. These are both complex eruptions, with reduced confidence due to limited STEREO A imagery, alongside further not-Earth directed CMEs contaminating imagery. These also give a chance of elevated solar winds with G1-G2 Minor to Moderate storms and a slight chance of isolated G3 strong storms.
Given the difficulties analysing multiple CMEs and further significant flaring expected there is a chance that further CMEs may arrive on days 3 and 4 (1 and 2 Aug). In isolation these events are most likely relatively weak, however should there be a combination of CMEs arriving in close proximity then geomagnetic responses may become significantly enhanced.
Aside from the CMEs, there are no further sources of enhancement expected, with initially Quiet slow wind conditions until the first arrival. After this, the CME influence is expected to dominate.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	60	60	50	40
Strong	G3	No	20	20	10	5
Severe	G4	No	5	5	5	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
28/0808 Combines with above.	Asymmetric Full	M9.9 AR3764	03 W 04 S	598 km/s	31/0200 -6 +12hrs	Likely combining with below
28/1838	Partial	M2.6 AR3767 M1.7 AR3768	18W 08 S	747 km/s	31/0200 -6 +12hrs	Complex analysis.

Figure 2:MOSWOC Enlil shows at least two further CME arrivals.

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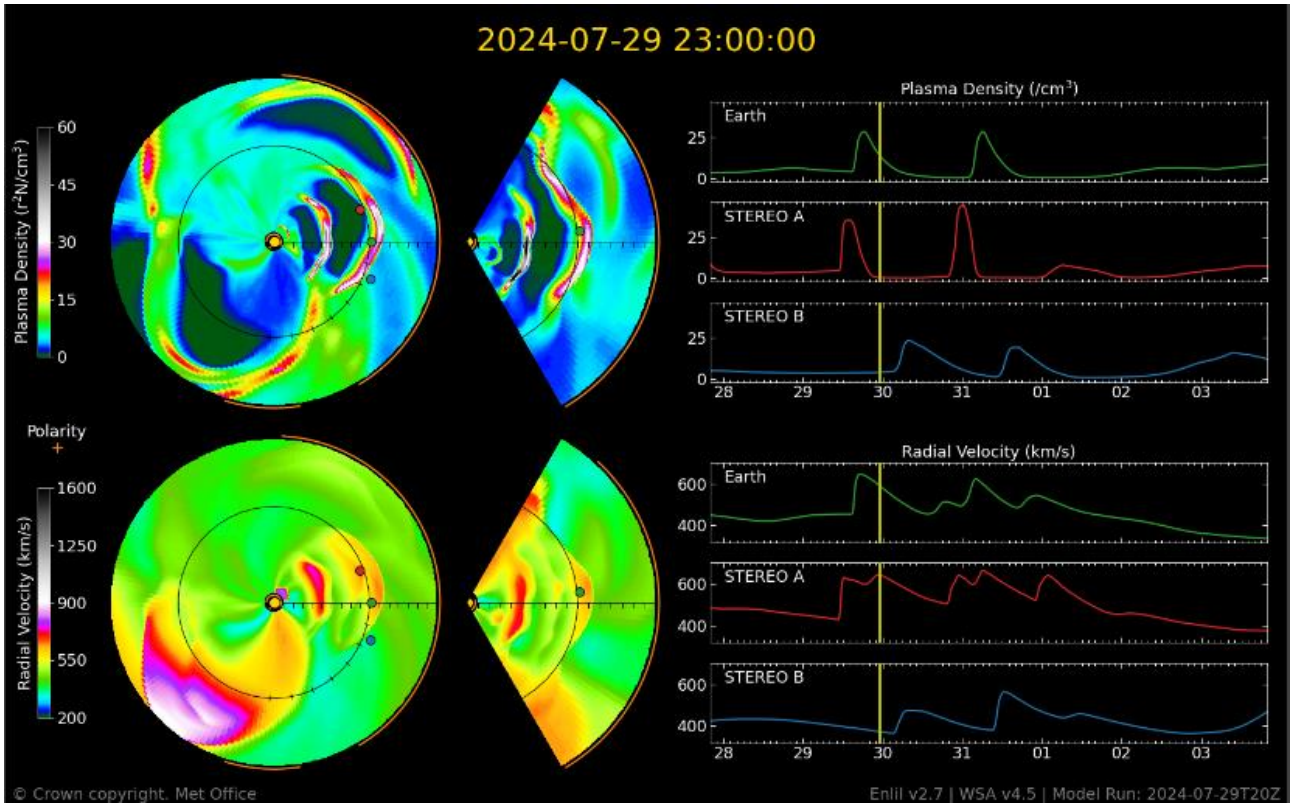

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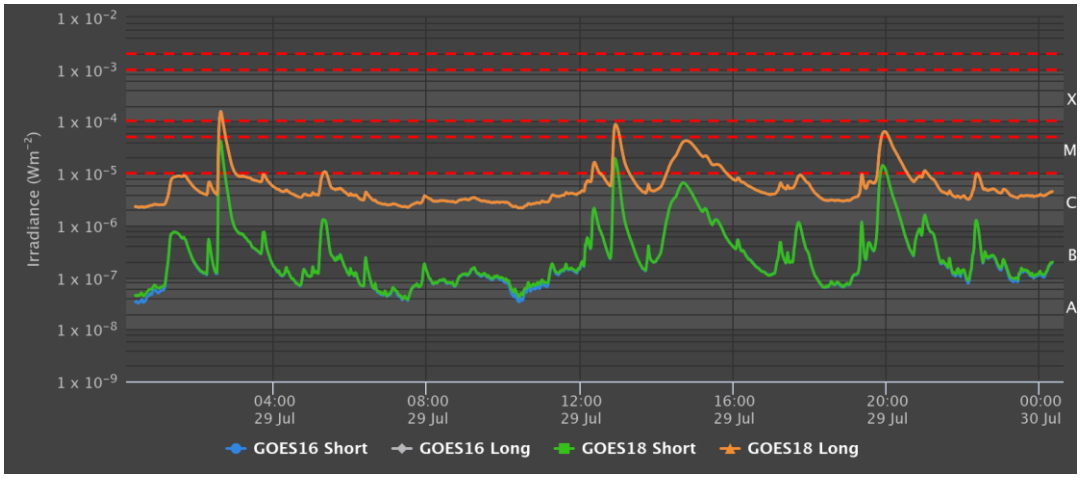
Radio Blackouts - X-Ray Flares:
High to Moderate activity is forecast, with M-class flares expected and a chance of further isolated X-class flares.
There are ten sunspot regions on the disc, including a number of moderately sized and complex regions. AR3762, near the southwest limb is showing some signs of decline, but maintains a small delta spot within its intermediate region. This is followed by AR3768 which has also slightly decreased in areal extent, but also maintains a small delta spot. A broad cluster of regions is then situated in the centre disc, including the combined region AR3764/AR3766, the source of the most recent X-flare. The proximity of these regions resulted in the formation of a delta spot, and may require reclassification at some later point. AR3765 and AR3767 are across the southernmost portion of this cluster, with the two regions showing ongoing growth and some sign of merging, with further complexity likely to develop. AR3770 in the north-centre disc has now slowed in development, but has developed a relatively strong delta spot, with further development remains likely.
Alongside the regions on the disc, there is the potential for a very active region to rotate onto the Earth-facing disc day 2 (31 Jul), the likely source of a couple of notable far-sided CMEs, with strong X-class flare activity also detected by the Solar Orbiter spacecraft. However, this is low confidence.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	80	80	80	80
Very Active	R3 to R5 X Class	Yes	20	20	20	20

Figure 3: GOES18 X-Ray Flux



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Solar Radiation Storms - (High Energy Protons):

High energy proton flux, as observed by GOES-18 is currently is currently at background but has the potential to see small rises in response to any notable flares on the disc, with a number of moderately sized and complex sunspots moving into the southwestern quadrant. This bring a slight chance of reaching the S1 Minor Radiation Storm level.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	15	15	15	15
Very Active	**≥ S3 ***	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

High Energy Electrons Event (≥ 2MeV):

High energy electron flux, as observed by GOES-16, is expected to be at background levels for much of the period. Recent fast wind enhancement did bring a small enhancement to Moderate levels at diurnal peak, however CME arrivals anticipated on days 1-2 (30-31 Jul) are likely to cause the observed flux at GEO to decline to background. There is some potential for a slight recovery as any CME influence recedes, however this is very low confidence, with mainly background levels most likely to persist

The associated 24 hr electron fluence is expected to remain below the Active level. Due to the expected CME arrivals MOSWOC REFM is likely to be variable in effectiveness, but providing good guidance until these occur.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	10	10	15	15
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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